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AN EVALUATION OF VARIOUS TYPES OF DISPOSABLE PALLETS IN UNITIZED SYSTEMS FOR FRESH CITRUS FRUITS

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PREFACE

This study is part of a broad research program by the Market Operations Research Laboratory, Agricultural Marketing Research Institute, Northeastern Region, Agricultural Research Service, U.S. Department of Agriculture, on marketing systems for fresh citrus.

The research was conducted at the National Agricultural Research Center, Beltsville, Md., Horticultural Research Laboratory, Orlando, Fl.; and Golden Gem Growers, Umatilla, Fl. Thomas Moffitt, Phillip Hale, and William Miller, researchers of Agricultural Research Service, Orlando, assisted in collecting the data.

The study was conducted under the general supervision of John C. Bouma, Chief, Market Operations Research Laboratory.

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AN EVALUATION OF VARIOUS TYPES OF DISPOSABLE PALLETS IN UNITIZED SYSTEMS FOR FRESH CITRUS FRUITS

by Joseph P. Anthony, Jr., and Robert C. Mongelli [1]

SUMMARY

Eleven disposable pallets were studied for possible use in unitized handling and shipping systems for fresh citrus fruits. Each pallet was evaluated according to these requirements: (1) They should be strong enough to withstand stresses from routine handling procedures and to lend stability to the handling unit and (2) they should cost no more than shippers could expect to recover in handling savings. Most of the pallets did not satisfy all these criteria. Problems encountered included high costs and weak construction causing pallet breakdown during handling tests. Only the corrugated fiberboard slipsheets met all the criteria, but specialized and expensive equipment attached to a forklift is required to handle them. However, because some fresh fruit shippers and many receivers already have this equipment, the corrugated fiberboard slipsheet appears to be the most desirable of the disposable pallets evaluated in unitized shipments of fresh citrus fruits. The wirebound pallets and one of the plastic foam pallets met all of the physical criteria but their cost was higher than the standard for evaluation.

INTRODUCTION

This report evaluates the potential of various disposable 48- by 40-inch pallets for use in unitized systems for handling and transporting fresh citrus fruits. These pallets are constructed from a number of materials, such as wood, corrugated fiberboard, and molded foam.

About 20 percent of all fresh fruits are currently being shipped from commercial production areas to urban markets in unit loads. This leaves a large area for potential utilization of palletized handling and transport.

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[1] Coauthors, listed alphabetically, are agricultural marketing specialists, Market Operations Research Laboratory, Agricultural Marketing Research Institute, Northeastern Region, Agricultural Research Service, USDA, Beltsville, Md.

Increasing labor costs and the scarcity of labor during the shipping season, coupled with the relatively low price per box of most fresh fruits are forcing shippers to look for ways to reduce shipping costs.

Unitized handling and shipping systems offer possibilities for significant reductions in labor costs and in product loss and damage. Unitization is being used extensively in the grocery industry for handling and shipping canned goods and other dry products. Its use for handling and shipping fresh fruits and vegetables has been minimal because of their bulky nature, lack of standarized boxes, and the special environmental conditions required for their protection during storage and transport.

In unitized handling multiple boxes are handled as a single unit, which normally requires a pallet of some sort to form the base of the handling unit. A pallet is defined as, "...a platform made to hold one or more boxes, bags, cartons, etc., in a group, thus permitting the load to be transported and stored as a unit". 2/ Wooden pallets were first introduced into industry in the late 1930's. The wooden pallet industry has grown from almost nothing before World War II to a half-billion-dollar-per-year industry. Over 15 percent of our nations hardwood lumber production is consumed by this industry. World War II created a need for materials-handling platforms and was mostly responsible for the development of the wooden pallet industry. Between 1940 and 1945, the Department of Defense used 55 to 60 million pallets. 3/

After the war the value of the pallet was beginning to be realized. Bolz said, "The pallet is one of the simplest and most important single devices in the whole range of modern materials handling equipment. It is the basis of the new philosophy of handling one at a time, and its use is thus the most obvious way to save time, money, and human effort in handling". 2/ The basis for this palletization is the pallet. At first only wooden pallets were used but other materials, such as steel, aluminum, fiberboard, plastics, have been introduced to build pallets for specific uses.

Two pallet sizes widely used to handle and transport fresh citrus fruits are 48 by 40 inches and 42 by 35 inches. The 48- by 40-inch size is the equivalent of the internationally accepted 1,200 by 1,000 millimeter and is the only pallet size recommended by the Grocery Pallet Council. The 48- by 40-inch pallet utilizes the available space in trucks more efficiently whereas the 42- by 35-inch pallet utilizes available space more efficiently in railcars. However, about 75 percent of all fresh fruits shipped are transported in trucks.

Using nonexpendable (reusable) pallets in one-way commercial shipments appears impractical because of weight, cost, repair requirements, storage problems, and problems of pallet return. The net weight of a reusable pallet ranges from 75 to 110 lb., adding a nonrevenue-producing weight of 1,350 to 1,980 lbs. to each shipment. Thus, the total weight of reusable pallets on each shipment will cause a 3.5- to 5-percent reduction in payload.

2/ Bolz, Harlod F.N. Materials Handling Handbook, The Ronald Press Company, 1958, p. 17.1.

3/ Lucas, John T., and Walter B. Wallin, The Department of Defense Market for Wooden Pallets: 1965, USFA Res. Paper NE-117, 1968, p. 2.

A pallet that is sufficiently strong and durable for reuse costs approximately $5. An initial investment of 18 pallets per shipment would cost $90, not counting additional inventory needs of shippers and receivers, and the cost of returning pallets to the shipping point.

Rough handling and normal wear frequently damage pallets, requiring repair before reuse. The need for labor, facilities, and materials to repair reusable pallets can increase their overall cost.

During the peak of the shipping season, most shippers' storage facilities are at a premium. Storing reusable pallets would often require additional facilities. Also, pallets might occupy valuable warehouse space at the receivers' facilities.

No pallet-pool arrangement exists in the fresh fruit and vegetable industry to handle and return reusable pallets. Such an arrangement is essential to the orderly repair, handling, storage, and distribution of the pallets among users. A pallet-pool arrangement between only one shipper and one receiver is impractical (from the shipper's viewpoint) because of initial inventory costs, deadhead return freight costs, the determination of responsibility, and sharing of costs for repairs, handling, storage, and distribution.

Therefore, the fresh fruit industry needs a suitable disposable pallet that can be used for unitized shipments.

Eleven wood, corrugated fiberboard, and plastic molded foam pallets were evaluated. Undoubtedly other disposable pallets were available in the United States, but the 11 that were evaluated were the only ones available to the researchers at the time of the study.

PROCEDURE

Tests were conducted in a central Florida packing plant. On site evaluations of pallet performance were made. Shippers evaluations and observations were recorded to supplement those of the researchers.

Performance

Most important is the load-supporting ability of the pallet. Considering the desirable pallet stacking patterns for handling fresh citrus fruits, the pallet should be able to accommodate a palletload of 2,500 lb. This allows 278 lb. more than the 2,222 lb. that can be accommodated in an 18-pallet-load trailer having a 40,000 lb. load limit.

The pallet should be able to carry this minimum standard weight (2,500 lb) in routine in-plant handling operations. This factor was considered the most important criteria in the reported series of tests. The pallets were observed and rated during the following stages of handling:

1. Empty before loading--each pallet was measured, weighed, and described before any of the 54 containers were stacked on it.

2. Loading--each pallet was loaded with 54-filled citrus shipping containers. The effects on the pallet during the stacking were noted.

3. Handling--each loaded pallet was picked up by a forklift truck and was carried through a series of routine handling procedures that simulate pallet handling and vehicle loading operations for expendable pallets. These procedures included:

   a. Pickup
   b. Move 50 ft
   c. Set down
   d. Slide 1.5 ft
   e. Pull out

4. Unloading--as each 54-box palletload was unloaded any structural defects were noted for each pallet.

5. Empty after unloading--the condition of each pallet was noted after the palletload was removed.

A pallet must also be immune to damage from low temperatures and moisture to be suitable for handling and shipping fruits. However, the moisture problems are not so severe for most fruits such as oranges and apples, as they are for many fresh vegetables such as celery and lettuce.

The conclusions of a group of shippers who observed the testing are included to give an indication of industry opinions on the various pallets.

Cost

There was no agreement of opinion among shippers on the highest pallet price they could pay and still recover the costs in handling savings. Examination of present expendable pallet costs in the Florida citrus industry was necessary to establish a standard for evaluation in this study. Many citrus shippers pay about 61 cents a piece for corrugated fiberboard slipsheets and ship many unitized loads per year on them. None of the shippers use standard hardwood (GMA) pallets which cost about $5 each for unitized shipments. The midpoint between these costs, $2.80, was selected as the standard for evaluation.

PALLET EVALUATION

Pallet A: Corrugated Fiberboard Small Blocks

This 48- by 40- by 5-inch pallet has a 1 1/2-inch corrugated fiberboard deck with nine 4- by 8- by 3 1/2-inch fiberboard blocks glued to the underside (fig. 1A and B). The four-way entry pallet weighed 8 lb.

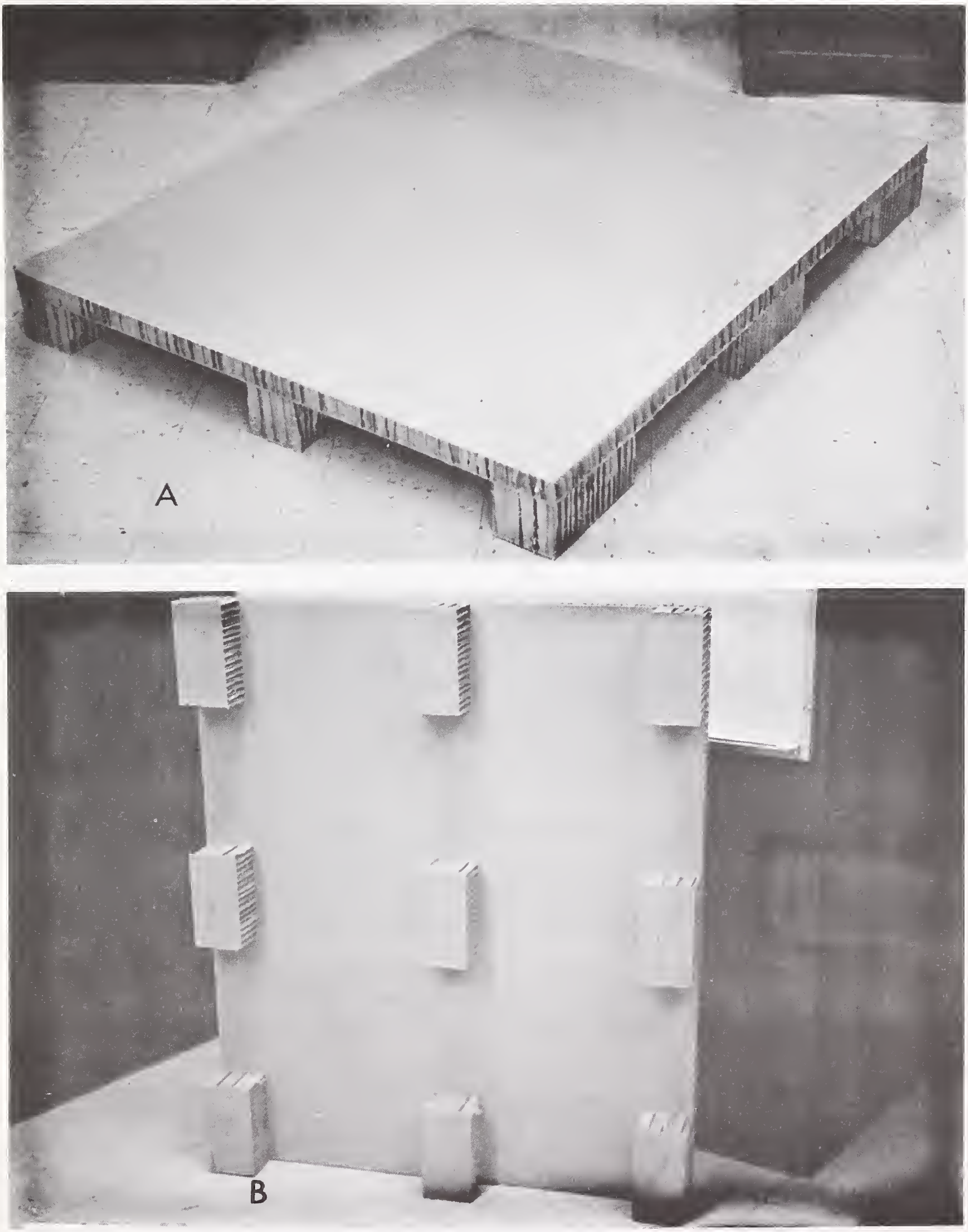

Figure 1.--Pallet A, corrugated fiberboard small blocks: A, top view and B, bottom view.

When loaded with the full palletload (2,500), the pallet displayed no signs of stress. When picked up, moved, and set down, the pallet was acceptable. The fiberboard blocks at the forward end of the pallet crushed during the sliding test (fig. 2). The forklift truck could pull out of the loaded pallet but the extreme forward list of the palletload could pose a potential safety hazard. Shippers questioned this pallet's susceptibility to moisture damage and inability to store in pallet racks, which would raise receiver complaints.

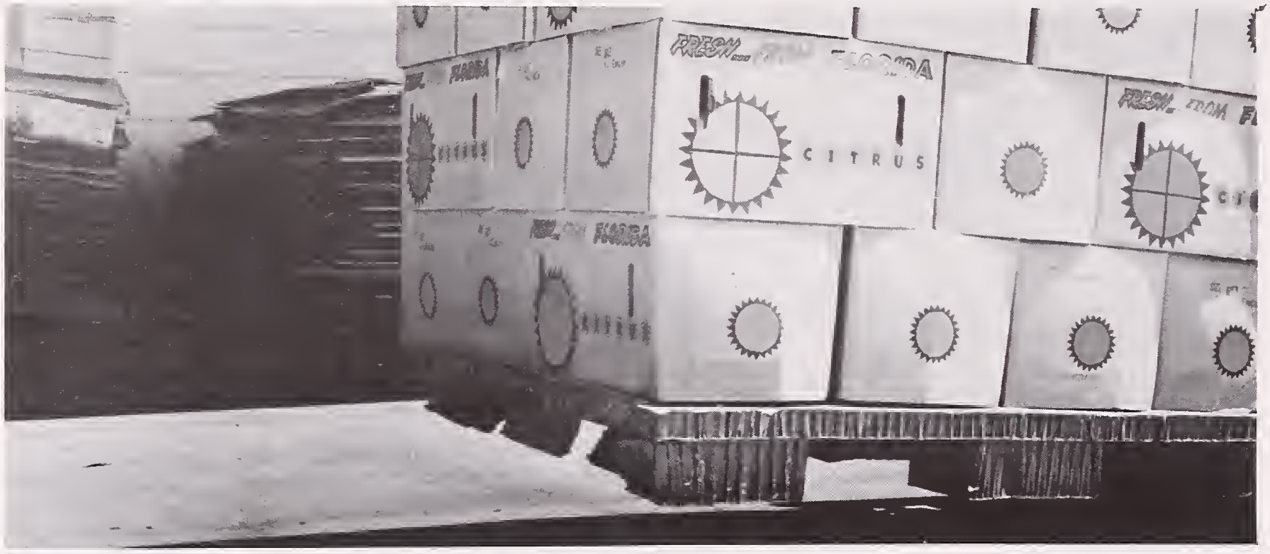

Figure 2.--Pallet A: the forward fiberboard small blocks were crushed during sliding test.

Pallet A was rated as unacceptable for use in handling and shipping systems for citrus fruits.

Pallet B: Corrugated Fiberboard Large Blocks

This 48- by 40- by 5-inch pallet was like Pallet A except the nine blocks glued to the underside were larger (6- by 9- by 3 1/2-inches). This four-way entry pallet weighed 8.75 lb, about 9 oz heavier than Pallet A (fig. 3, A and B).

During the loading of this pallet, a corner block on one of the pallets showed signs of compression. This did not affect the testing of this pallet and did not occur with other Pallet B's. During the sliding test, the forward blocks crushed as they did on Pallet A (fig. 4). The forklift truck could not pull out from under this load because the pallet could not support its load after the block failure. Moisture absorption damage was rated by shippers to be a big drawback in using this pallet.

Pallet B was rated as unacceptable for general use in handling and shipping systems for fresh citrus fruits.

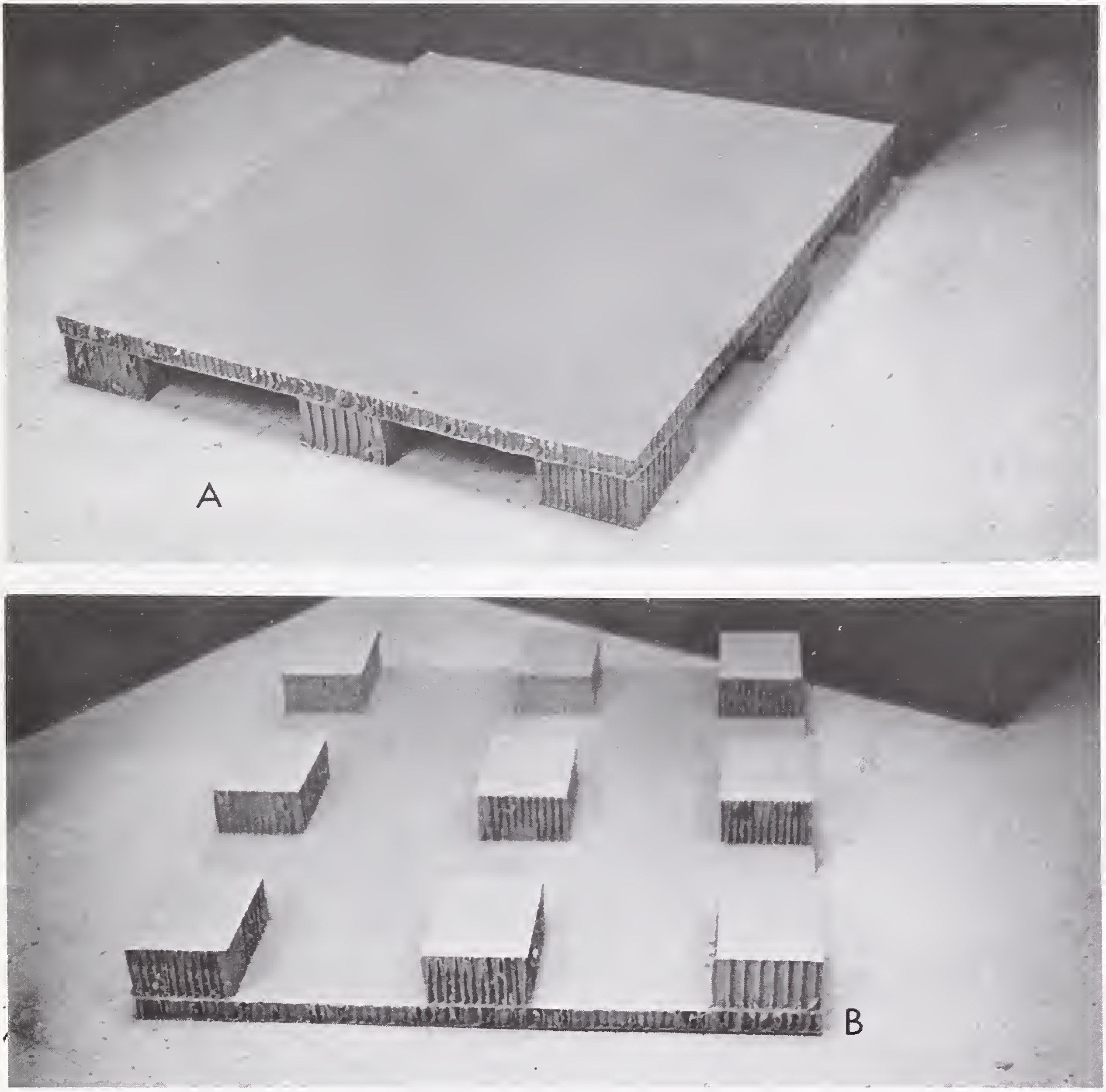

Figure 3.--Pallet B, corrugated fiberboard large blocks: A, top view and B, bottom view.

Pallet C: Corrugated Fiberboard Folding Runners

This 48- by 40- by 4 1/4-inch pallet has a 2 1/8-inch corrugated fiberboard deck with three 4- by 40- by 2 1/8-inch fiberboard runners glued to the underside (fig. 5, A and B). The two-way entry pallet weighed 10 1/4 lb. This pallet assembled at the shipping point was shipped with the three runners partly cut from the deckboard (background of fig. 5 A) and preglued with a self-adhering adhesive. Assembly was quick, clean, and easy.

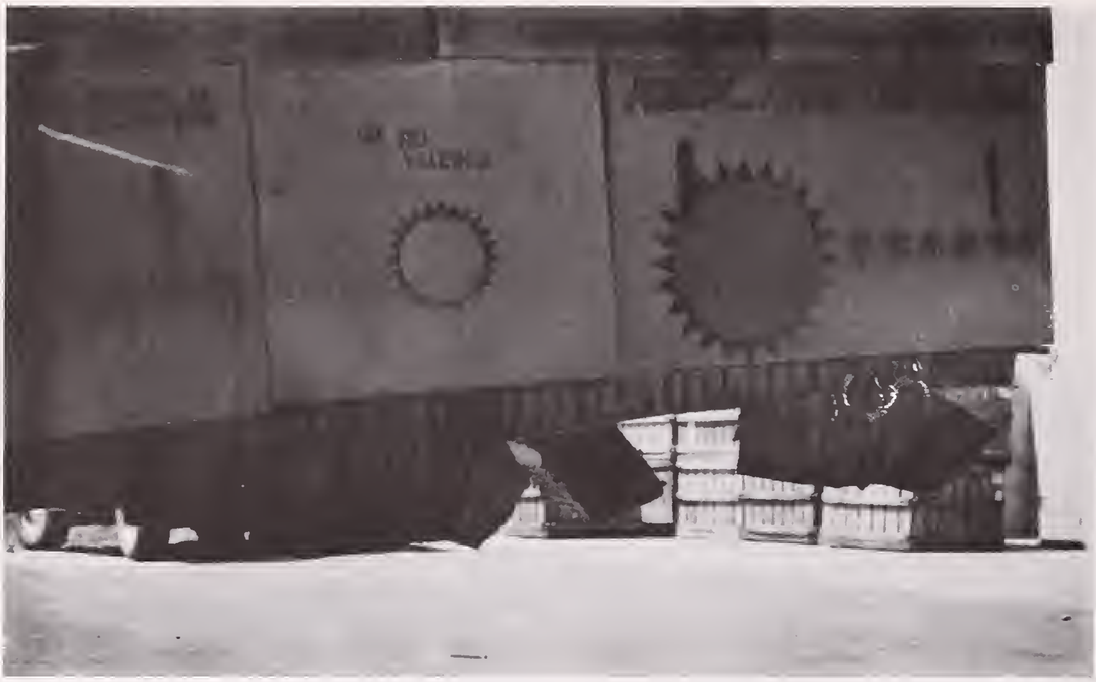

Figure 4.--Pallet B, the forward fiberboard large blocks were crushed during sliding test.

When stacked with the full palletload (2,500 lb), the pallet displayed no signs of stress. When picked up, moved, and set down, the pallet was acceptable. During the sliding test, the forward end of the runners were crushed (fig. 6). The forklift truck could pull out of the loaded pallet but the extreme forward list of the palletload could pose a safety hazard. The shippers felt that moisture would damage this pallet. The low entry on this pallet would not allow the use of palletjacks and this was a big drawback to the shippers.

Pallet C was rated as unacceptable for use in handling and shipping systems for fresh citrus fruits.

Pallet D: Corrugated Fiberboard Blocks and Runners

This 48- by 40- by 6-inch pallet has a 2-inch corrugated fiberboard deck with nine 6- by 9- by 2-inch fiberboard blocks and three 6- by 2-inch fiberboard runners glued to the underside (fig. 7, A and B). The four-way entry pallet weighed 13 1/2 lb.

The pallet displayed no signs of stress when loaded with a full palletload. When picked up, moved and set down, the pallet was acceptable. During the sliding test, the fiberboard runners at the forward end of the runners were crushed (fig. 8). The forklift truck could pull out of the load but the palletload was too unstable to stand alone. Shippers again questioned this pallet's susceptibility to moisture damage and inability to be stored in racks.

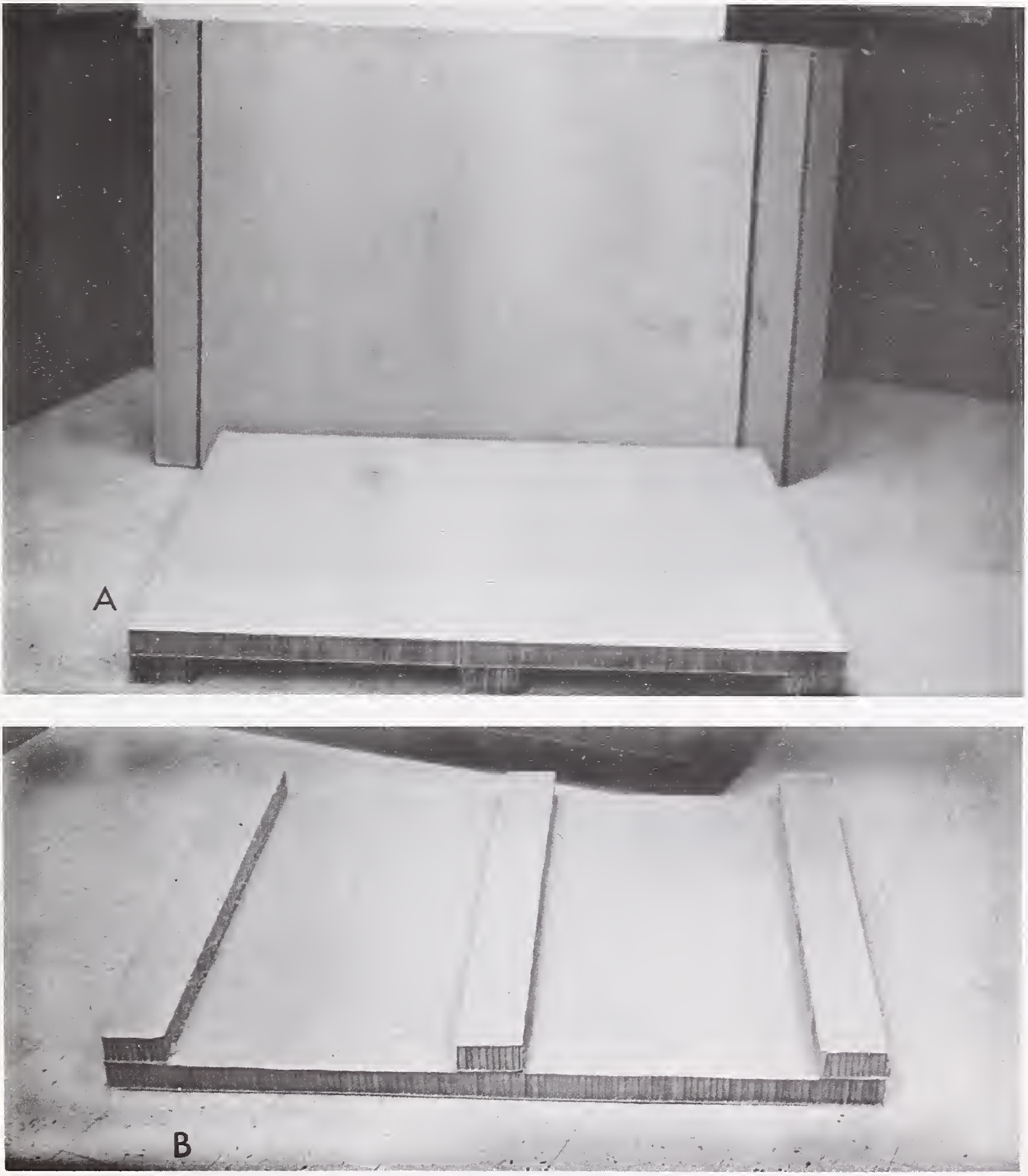

Figure 5.--Pallet C, corrugated fiberboard folding runners: A, top view and before assembly, and B, bottom view.

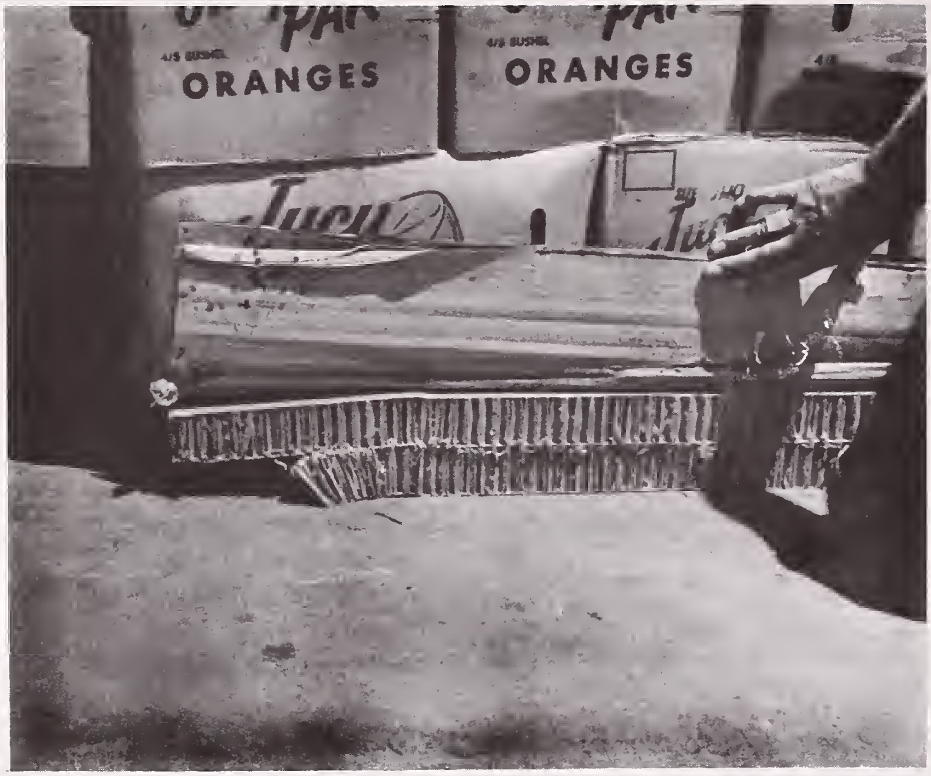

Figure 6.--Pallet C, forward end of the fiberboard folding runners were crushed during sliding test.

Pallet D was rated as unacceptable for use in handling and shipping fresh citrus fruits.

Pallet E: Corrugated Fiberboard Double Blocks

This 48- by 40- by 6-inch pallet has a 2-inch corrugated fiberboard deck with nine 6- by 9- by 2-inch double fiberboard blocks (18) glued to the underside (fig. 9, A and B). The 2-inch thick double blocks provided 4-inch clearance on all entry. Pallet E weighed 12 pounds.

When loaded with the full palletload (2,500 lb), the pallet displayed no signs of stress. When picked up, moved, and set down the pallet was acceptable. The fiberboard blocks at the forward end of the pallet crushed during the sliding test (fig. 10). The forklift truck could pull out of the palletload but the load had a decided forward list and could not remain that way. Shippers doubted this pallet's usefulness in shipping and felt the moisture damage would undermine the total structual integrity of the pallet.

Pallet E was rated as unacceptable for use in handling and shipping fresh citrus fruits.

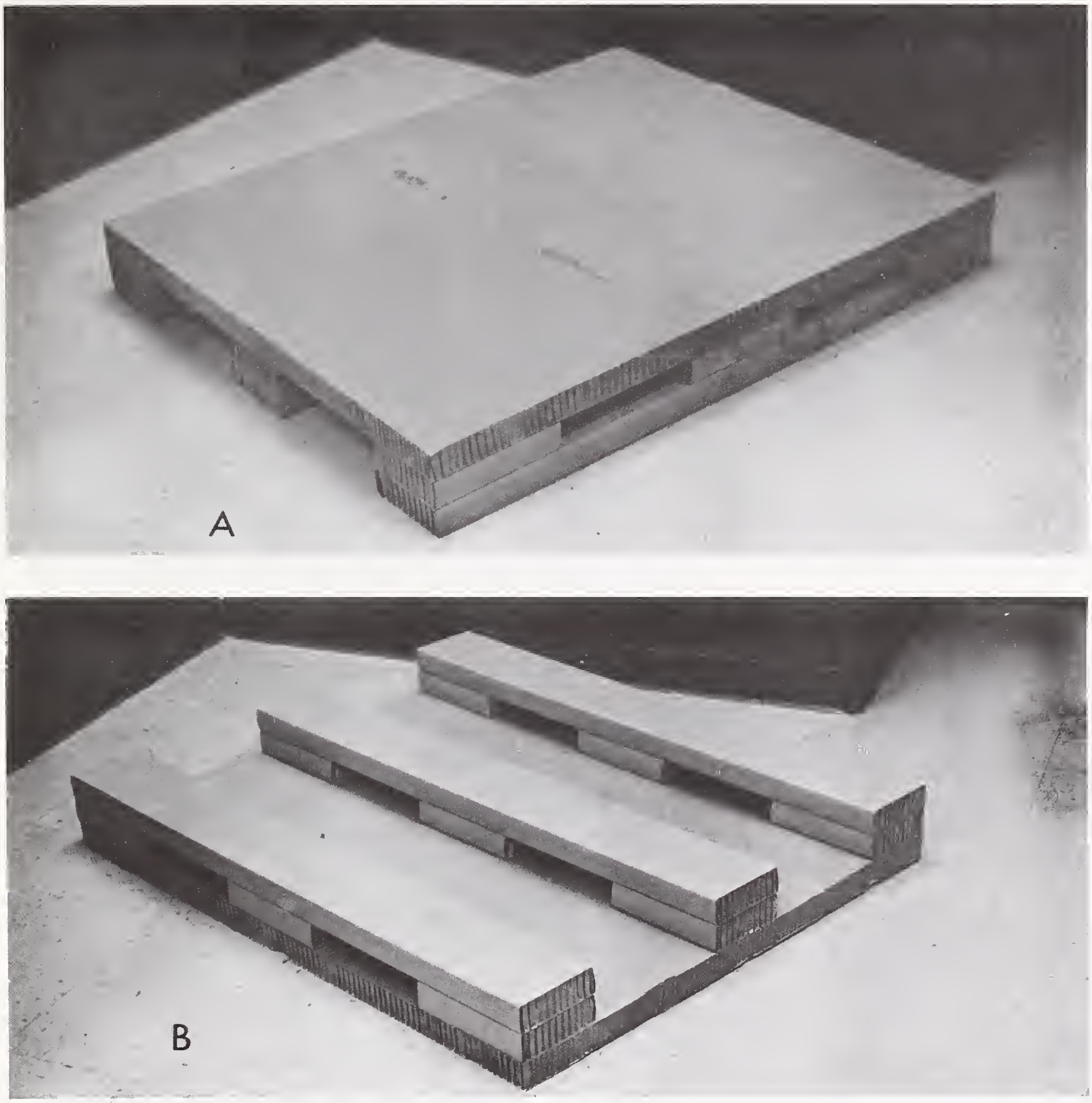

Figure 7.--Pallet D, corrugated fiberboard blocks and runners: A, top view and B, bottom view.

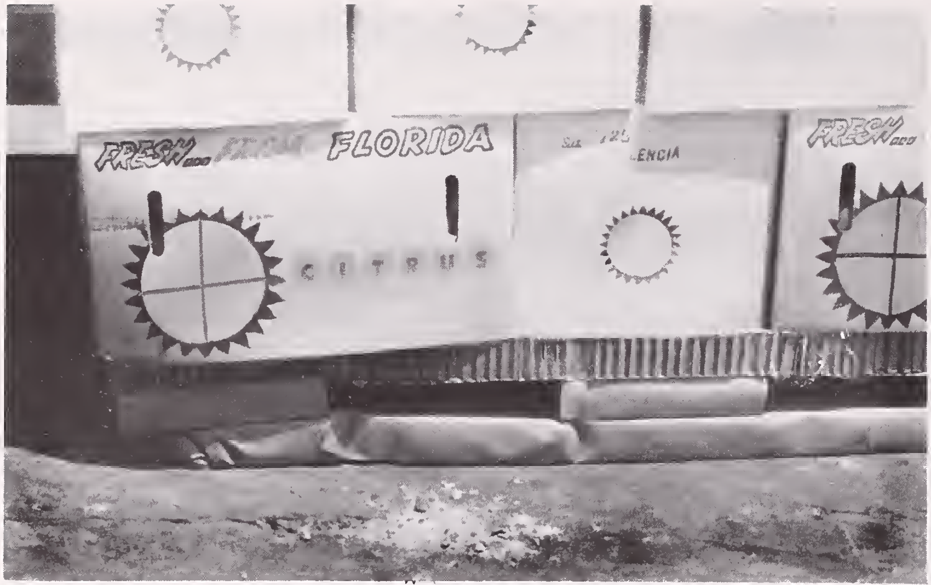

Figure 8.--Pallet D, forward end of fiberboard blocks and runners were crushed when slid.

Pallet F: Corrugated Fiberboard Slipsheet

This 52- by 40- by 1/8-inch corrugated fiberboard pallet has a 48- by 40-inch load surface with a 4 inch lip (fig. 11). Test strength was 275 lb. This one-way entry slipsheet has an 8-inch hole cut in the center of the load surface to provide air circulation. The weight of the slipsheet is between 1 and 2 pounds. Slipsheets are now being used for handling and transporting citrus in Florida.

When loaded with a full palletload (2,500 lb), the slipsheet displayed no signs of stress. When picked up, moved, slid, and set down the slipsheet was acceptable.

To handle slipsheeted loads a special expensive attachment that grips the lip of the slipsheet and provides a broader lifting base must be added to a forklift truck. The ownership and operating costs for this attachment add about 4 cents per slipsheet to the cost of handling products on a slipsheet. 4/

Pallet F was rated as acceptable for use in handling and shipping systems for fresh citrus fruits.

4/ Using a purchase and installation cost of $7,000, depreciation, interest, insurance, taxes, power, and maintenance were calculated and allocated to 35,000 slipsheet handling per year.

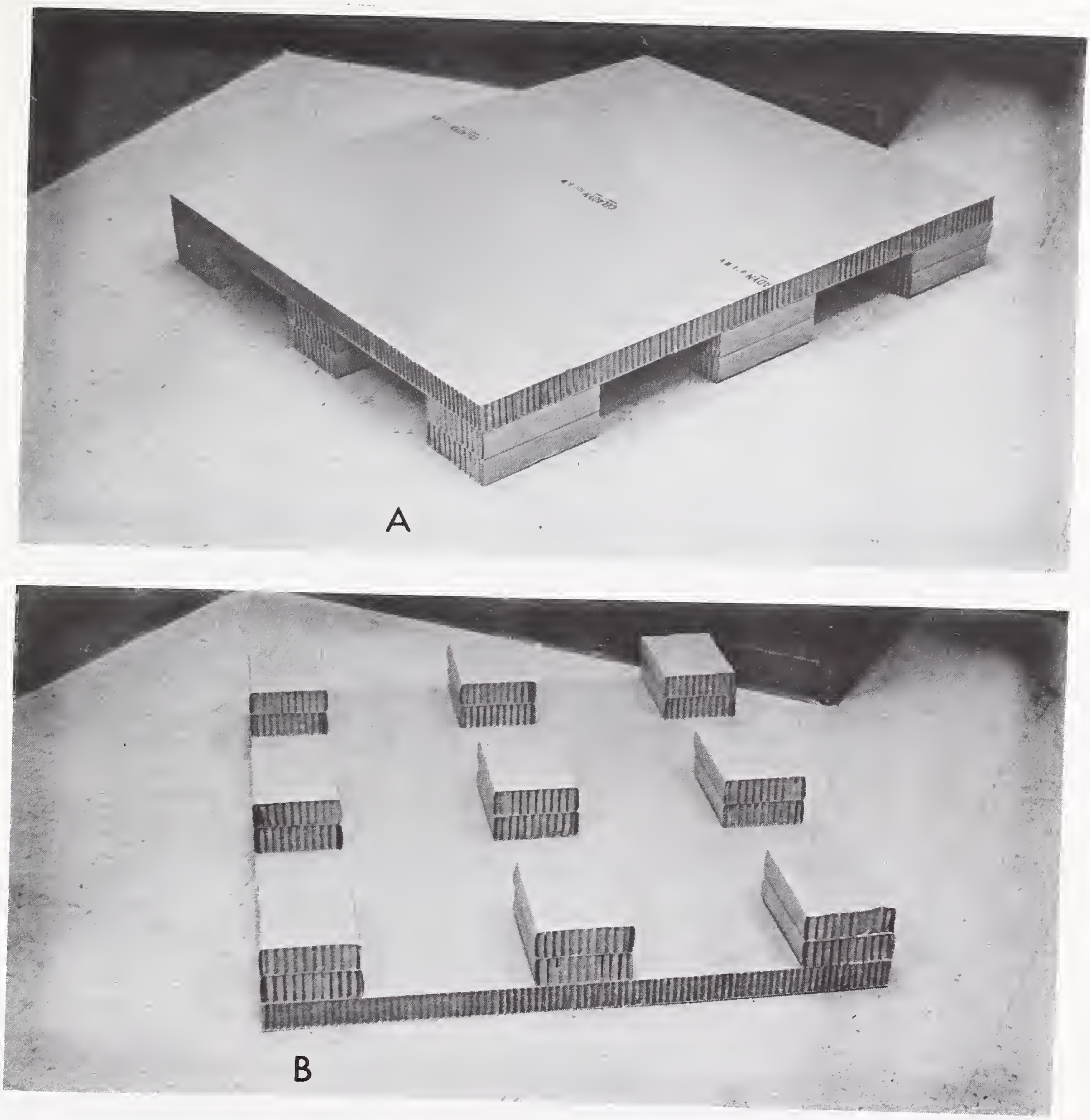

Figure 9.--Pallet E, corrugated fiberboard double block: A, top view and B, bottom view.

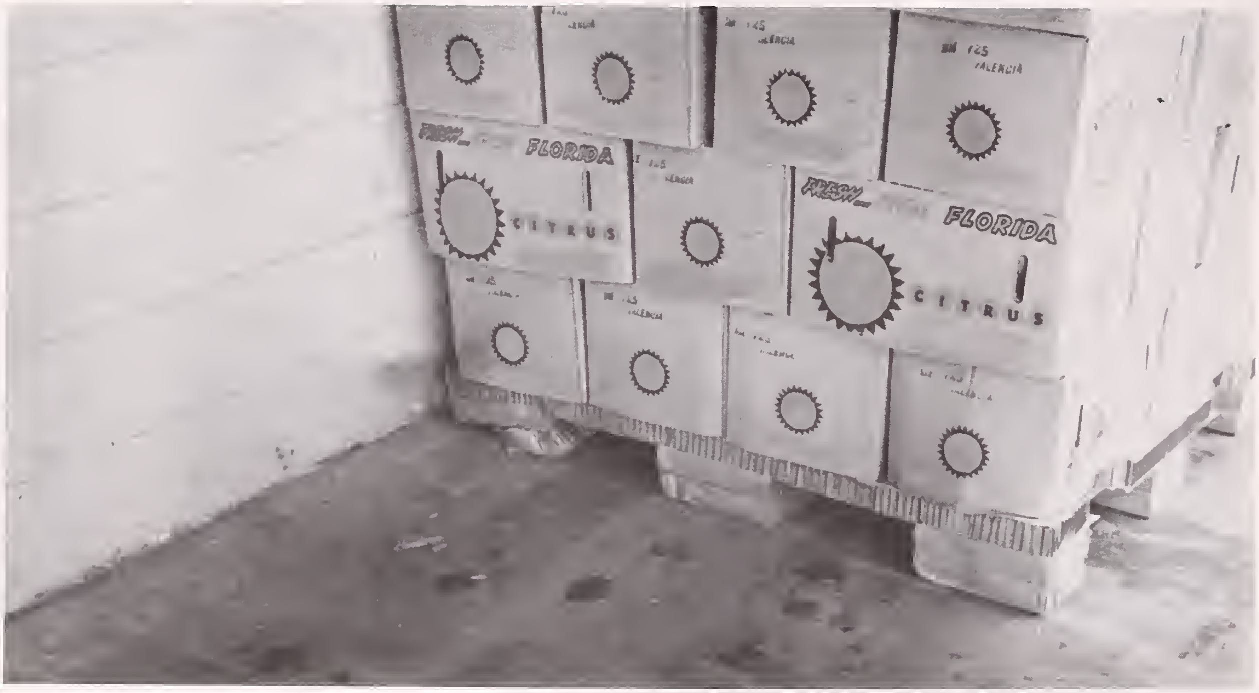

Figure 10.--Pallet E, forward end of the fiberboard double blocks were crushed during sliding test.

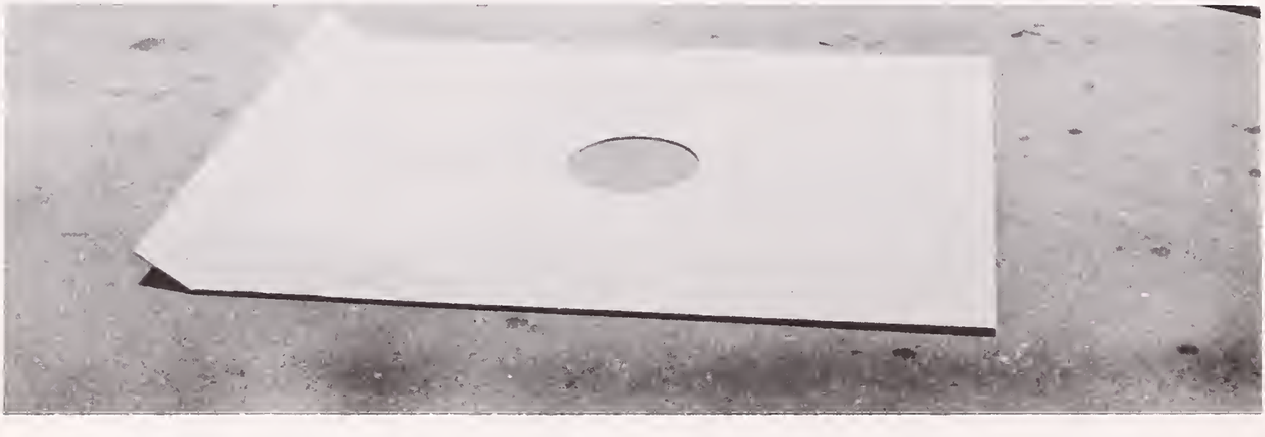

Figure 11.--Pallet F, top view of corrugated fiberboard slipsheet.

Pallet G: Plastic Foam Blocks

This 48- by 40- by 5-inch pallet has a 1-inch deck with nine blocks molded in the underside (fig. 12, A and B). The four-way entry pallet weighes 11 1/4 pounds. After loading with a full palletload, the pallet showed no signs of stress when picked up, moved, slid, or set down. A few small chips were ground off the blocks when slid but these were of no consequence (fig. 13). Shippers raised questions about the suitability of this pallet because it cannot be used in pallet racks. This could be a big problem at the receiver's facilities. Because the pallet's cost exceeded the cost criterion it was rated as unacceptable for use in handling and shipping systems for fruits.

Pallet H: Plastic Foam Runners

This 48- by 40- by 5-inch pallet has a 1-inch molded foam deck with four runners molded into the bottom (fig. 14, A and B). The outer surface of the pallet is covered with kraft paper. The two-way entry pallet weighs 9.9 pounds.

When loaded with the full palletload, the pallet displayed no signs of stress. During the handling operations, a slight sag was noticed along one side of the pallet but this appeared to be acceptable. After the forklift truck pulled out of the pallet, the damage to the rear end of the deck and permanent distortion of one entire side of the deck was observed (fig. 15). The damage from this minimal testing caused researchers and shippers to question the suitability of this pallet.

Pallet H was rated as unacceptable for use in handling and shipping systems for fresh citrus fruits.

Pallet I: Wirebound Winged Runners

This 48- by 40- by 4 1/4-inch nonreversible wooden pallet is reinforced along its three wood runners by a heavy wire binding stapled to the runner through the deckboards. The staples serve the dual purpose of holding both the the deckboards and the wires (fig. 16, A and B). This two-way entry pallet weighted 19.9 lb.

When loaded with a full palletload (2,500 lb), the pallet displayed no signs of stress. When picked up, moved, set down, and slid, the pallet was acceptable. A slight shift (1/2 inch) of the top runners occurred during the sliding test (fig. 17).

Shippers showed some interest in this pallet, but questioned use of this pallet in palletracks, use with palletjacks, and the cost. Because this pallet cost exceeded the cost criterion it was rated as unacceptable for use in handling and shipping fresh citrus fruits.

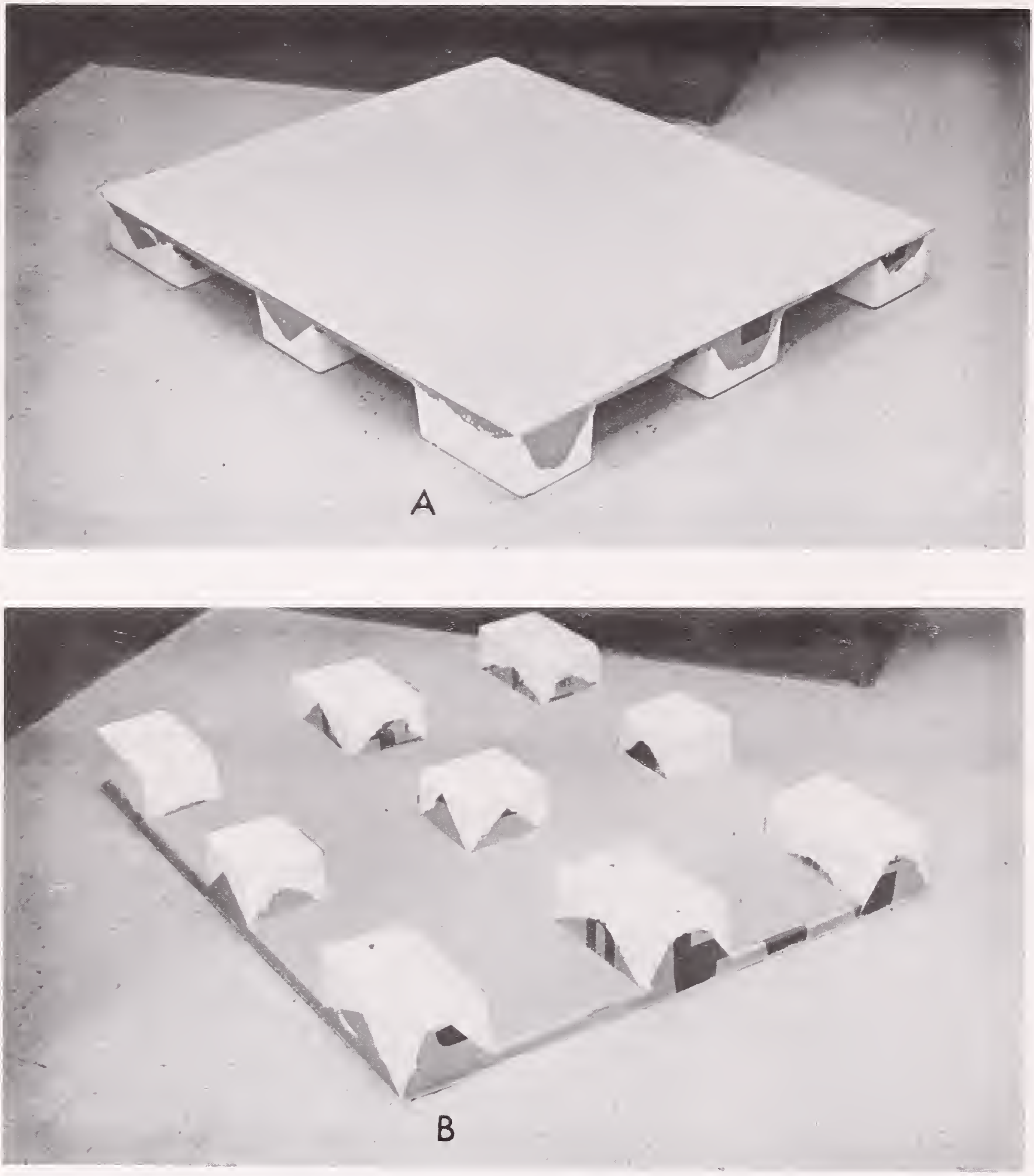

Figure 12.--Pallet G, plastic foam blocks: A, top view and B, bottom view.

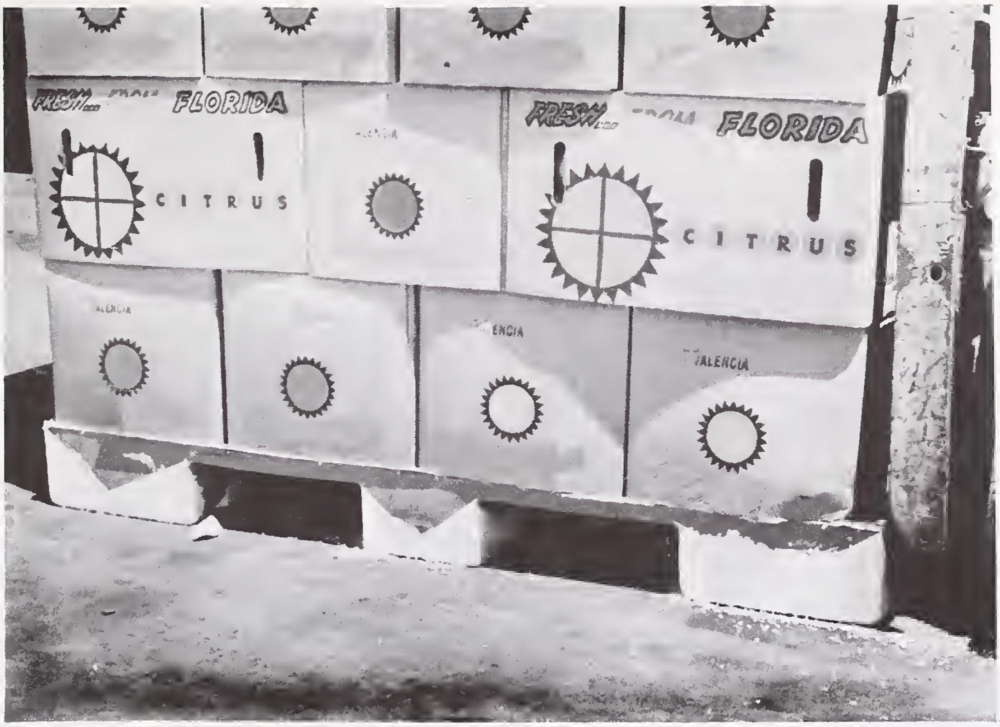

Figure 13.--Pallet G, plastic foam blocks, small chips were ground off of the bottom of the pallet during the sliding test.

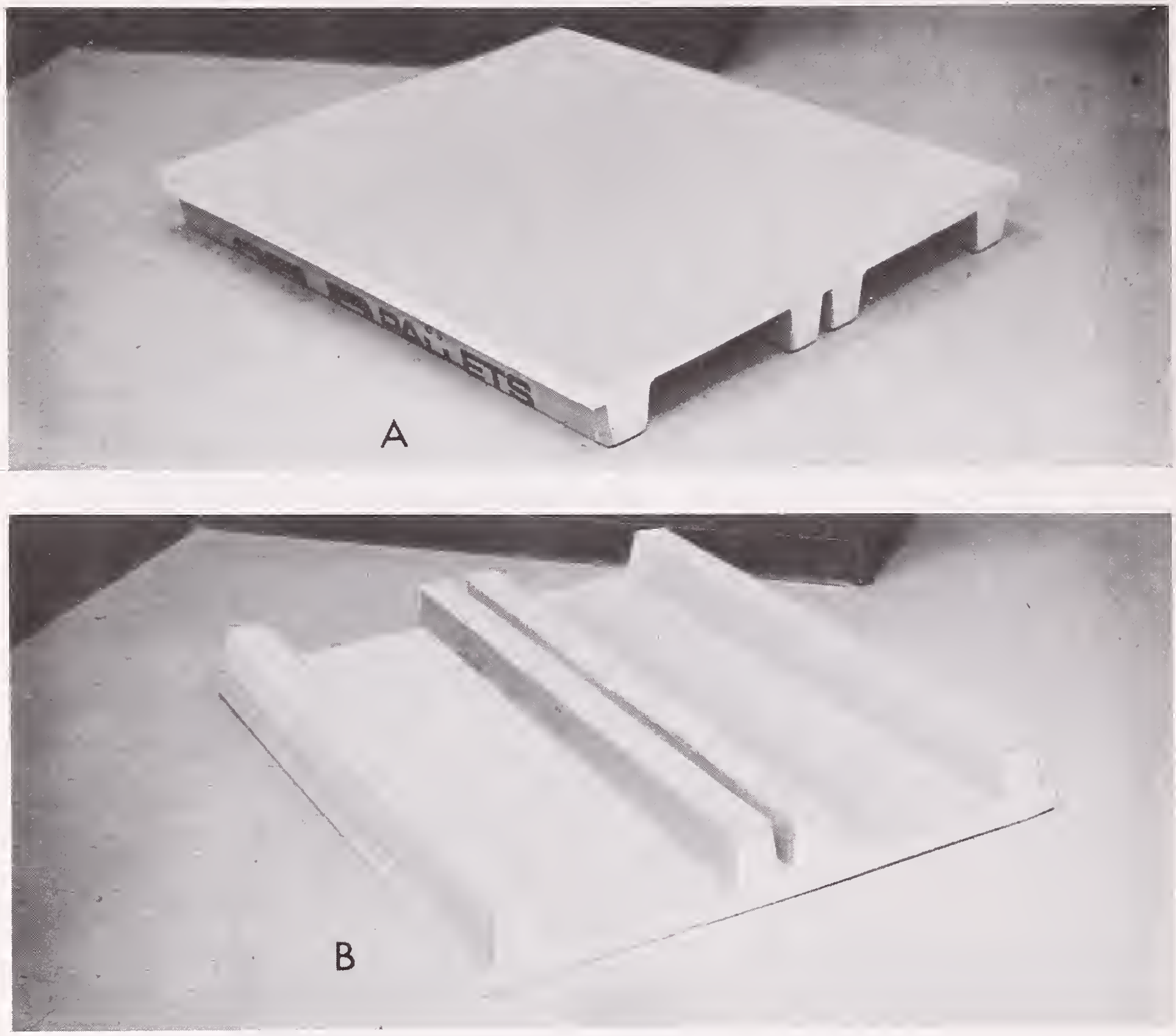

Figure 14.--Pallet H, plastic foam runners: A, top view and B, bottom view.

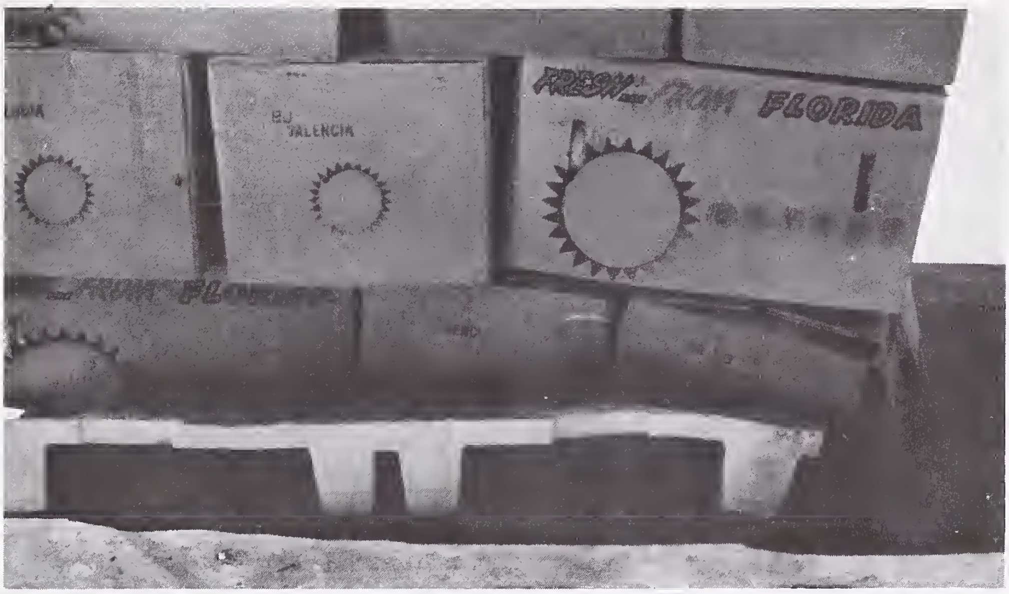

Figure 15.--Pallet H, plastic foam runners, during handling operations pallet's deck was damaged.

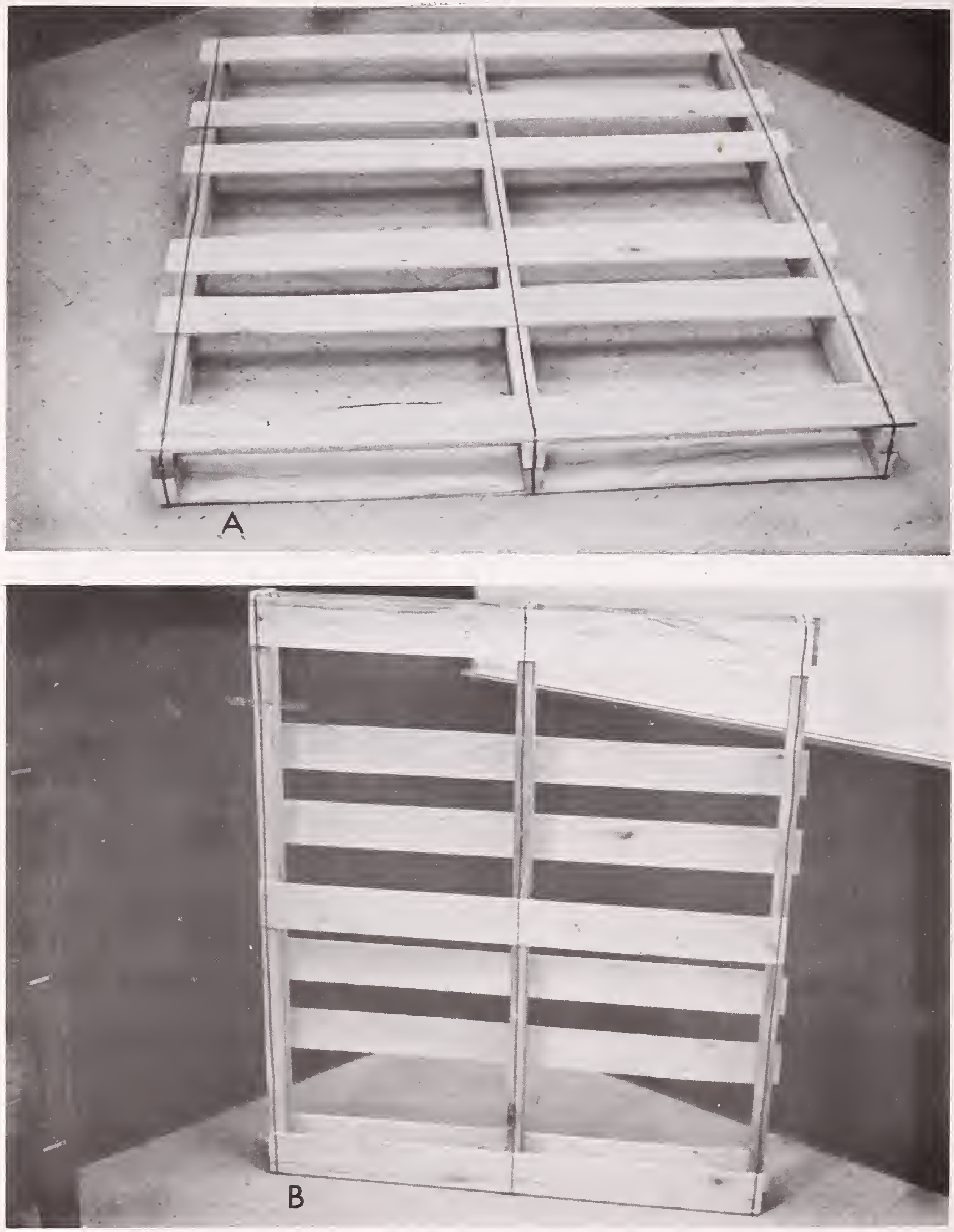

Figure 16.--Pallet I, wirebound winged runners: A, top view and B, bottom view.

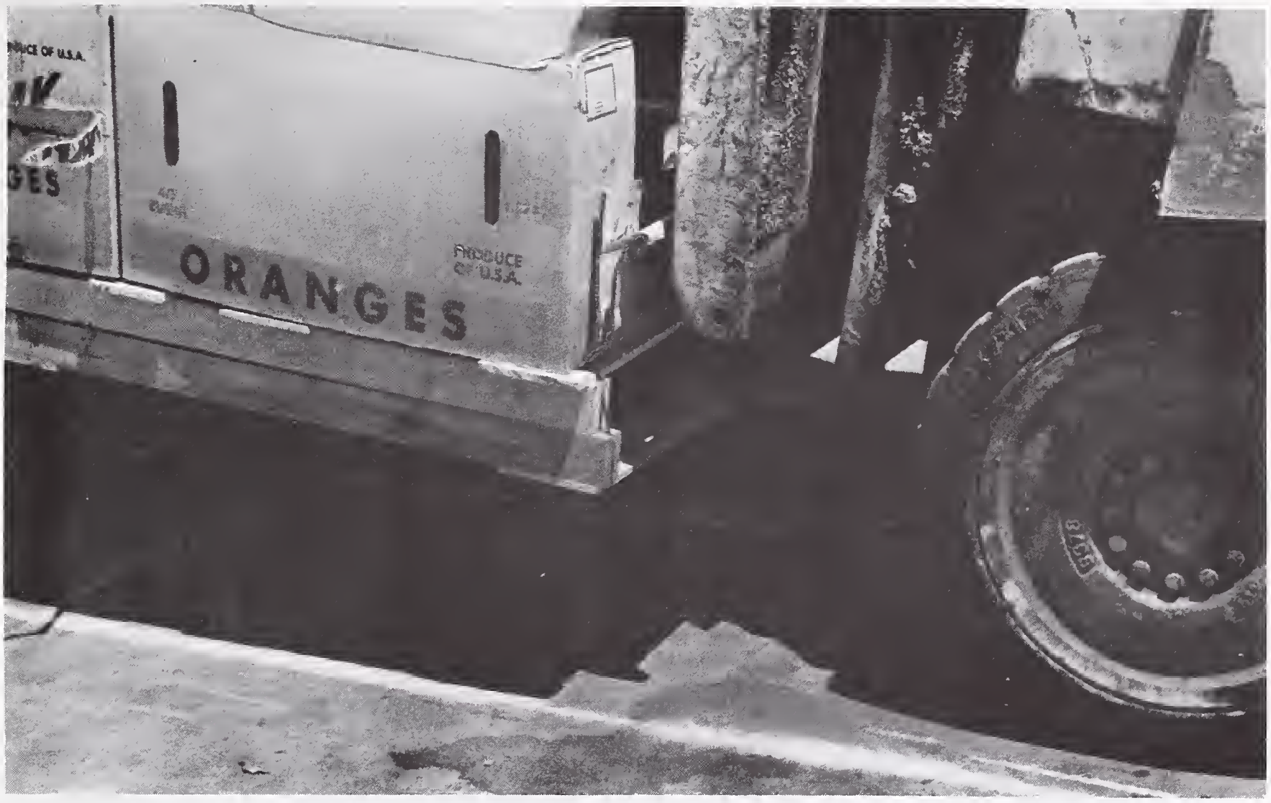

Figure 17.--Pallet I, wirebound winged runners, during sliding test, slight shifting of runners occurred.

Pallet J: Wirebound Large Runners

This 48- by 40- by 4 1/4-inch nonreversible wooden pallet is reinforced along its three wood runners by a heavy wire binding stapled to the runners through the deckboards. The staples serve the dual purpose of holding both the deckboards and the wires (fig. 18, A and B).. Runners are made with 1 1/8-inch stock. This two-way entry pallet weighted 22.8 lb.

The testing results for this pallet were identical to that of Pallet I (see text for Pallet I and figure 17). This pallet was rated as unacceptable because its cost exceeded the cost criterion.

Pallet K: Wirebound Small Runners

This 48- by 40- by 4 1/4-inch nonreversible wooden pallet (fig. 19, A and B) is identical in construction to Pallet J except that the wood runners for this pallet are made with 1-inch stock instead of 1 1/2-inch stock as in Pallet J. Pallet K has two-way entry and weighs 19.5 lb.

The testing results were the same for this pallet as for Pallet I (see text for Pallet I and figure 17). This pallet was rated as unacceptable because its cost exceeded the cost criterion.

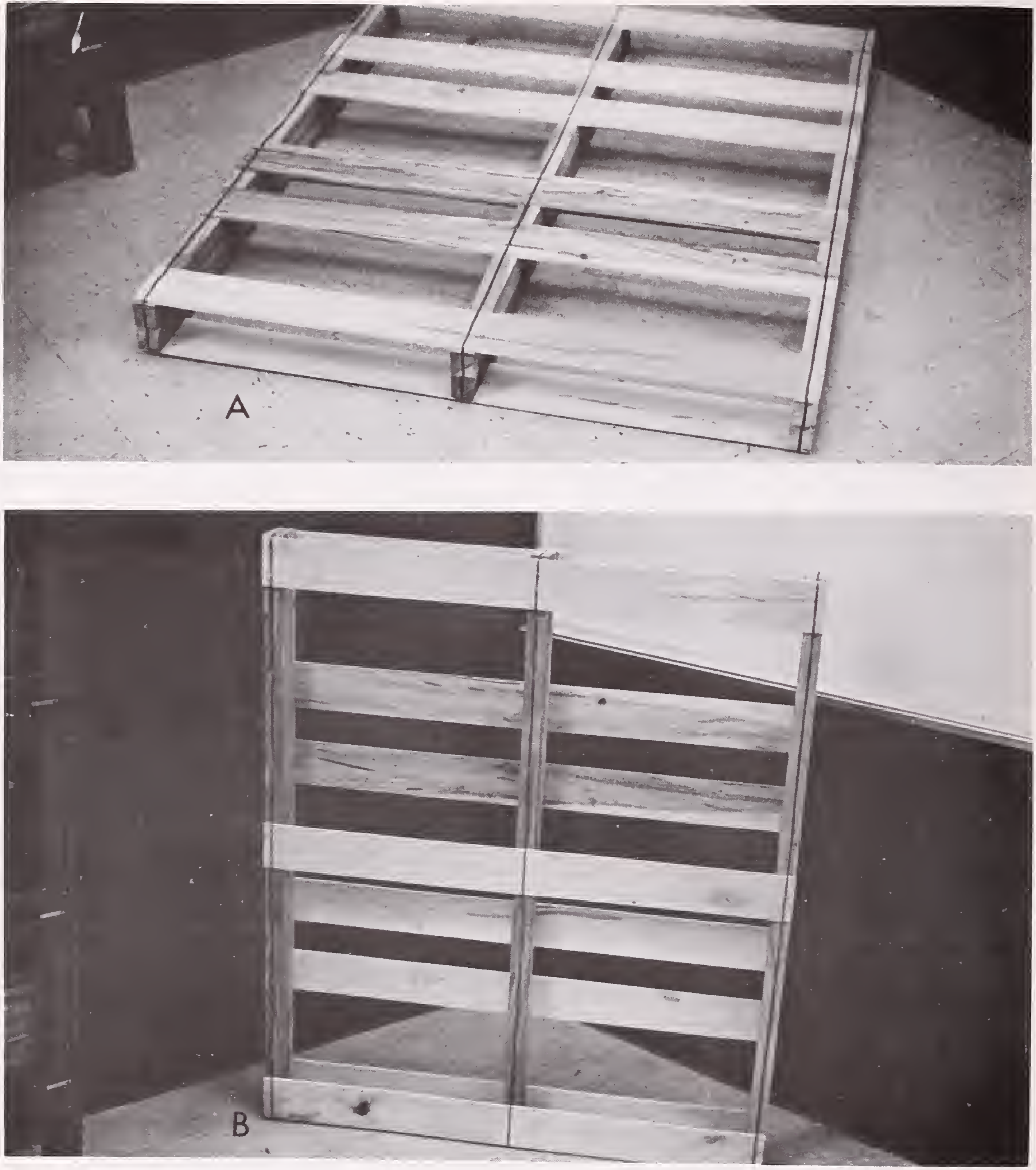

Figure 18.--Pallet J, wirebound large runners: A, top view and B, bottom view.

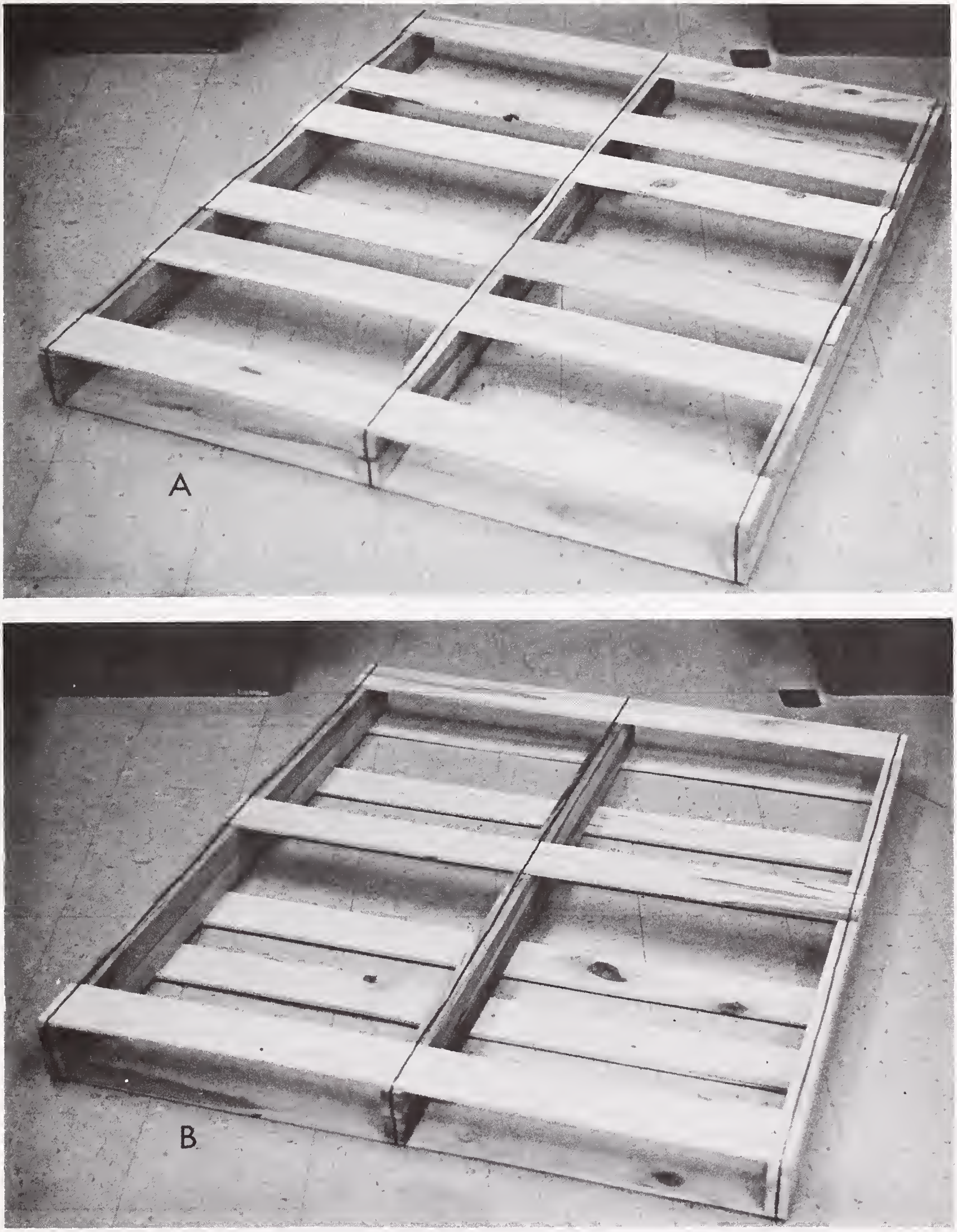

Figure 19.--Wirebound small runners: A, top view and B, bottom view.

DISCUSSION

Table 1 lists all of the pallets evaluated and summarizes the results of this research.

Of the 11 disposable pallets evaluated, only the corrugated fiberboard slipsheet (pallet F) with 275-pound test strength met the performance and cost criteria discussed in this publication. The shippers considered other pallets either too expensive or too weak for use in unitized handling and shipping of fresh citrus fruits. Modifications to strengthen the pallets would increase the cost so much that shippers would no longer consider them "disposable."

Slipsheets have disadvantages, however. They will tear if they become impregnated with moisture. Also special expensive equipment must be added to the forklift for handling loads on slipsheets. Slipsheets can be used in pallet racks but must be placed on a permanent pallet to do so. Some shippers and many receivers of fresh fruits already have this special equipment. Large food distribution warehouses use this attachment for forklifting canned goods and other dry grocery products.

Four other pallets, the three wooden wirebound and one plastic foam pallet were satisfactory in all of the handling tests but their prices all exceeded the acceptable cost. Shippers had doubts about the use of these pallets in palletracks because, unlike slipsheets, heights of these pallets do not allow them to be placed on permanent pallets for storage.

Table 1.--Summary of descriptions and test results on 48- by 40-inch disposable pallets

Pallet	Name	Entry		Weight	Cost 2/	Test Results 1/					
							Handling strength				
		Height	Style			Payload strength	Pickup	Move	Set down	Slide	Pull out
		Inches		Pounds	Dollars						
A	Corrugated fiberboard small blocks	3.5	Four-way	8.0	2.03	S	S	S	S	U	S
B	Corrugated fiberboard large blocks	3.5	Do	8.8	2.87	S	S	S	S	U	U
C	Corrugated fiberboard folding runners	2.1	Two-way	10.3	(3/)	S	S	S	S	U	S
D	Corrugated fiberboard blocks and runners	4.0	Four-way	13.5	3.51	S	S	S	S	U	U
E	Corrugated fiberboard double blocks	4.0	Do	12.0	3.16	S	S	S	S	U	U
F	Corrugated fiberboard slipsheet	.1	One-way	1.0	4/ .65	S	S	S	S	S	S
G	Plastic foam blocks	4.0	Four-way	11.3	5.25	S	S	S	S	S	S
H	Plastic foam runners	4.0	Two-way	9.9	5.25	S	S	S	S	S	U
I	Wirebound winged runners	3.5	Do	19.9	4.55	S	S	S	S	S	S
J	Wirebound large runners	3.5	Do	22.8	5/ 4.50	S	S	S	S	S	S
K	Wirebound small runners	3.5	Do	19.5	4.47	S	S	S	S	S	S

1/ S = Satisfactory. Passed this portion of the evaluation.
U = Unsatisfactory. Did not pass this portion of the evaluation.

2/ Pallet costs as of June 1976 are f.o.b., place of manufacture.

3/ Experimental pallet; cost not available.

4/ Cost includes 61 cents for purchase of slipsheet plus ownership and operating costs for the special attachment for the forklift truck of 4 cents per slipsheet.

5/ Estimated.

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